Preposterous* Precipitation – A Practitioner's Prerspective

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Extreme Precipitation Workshop
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** "beyond reason & convention" thesaurus category*

Where are the Practitioners?

- Agriculture
- Stormwater *
- Hydrology / Hydraulics *
- Water Supply
- Sewer Districts
- Watershed Management
- Ecohydrology *
- ***Transportation*** **

Apologies to Prof. Frink

Extremes - A Matter of Scale

- Space
  - 10^{-3} mi^2 to 10^{3+} mi^2
- Time
  - 5 min to 72+ hrs
  - Weeks to months to years!

- Time & Space often go hand in hand
  - larger watersheds imply longer time scales
- Identified Needs also dictate scales
  - Ag & Water Supply: seasonal, annual, multi-year
  - Hydraulic structures: event-based – minutes to hours

Not All Extremes are Big

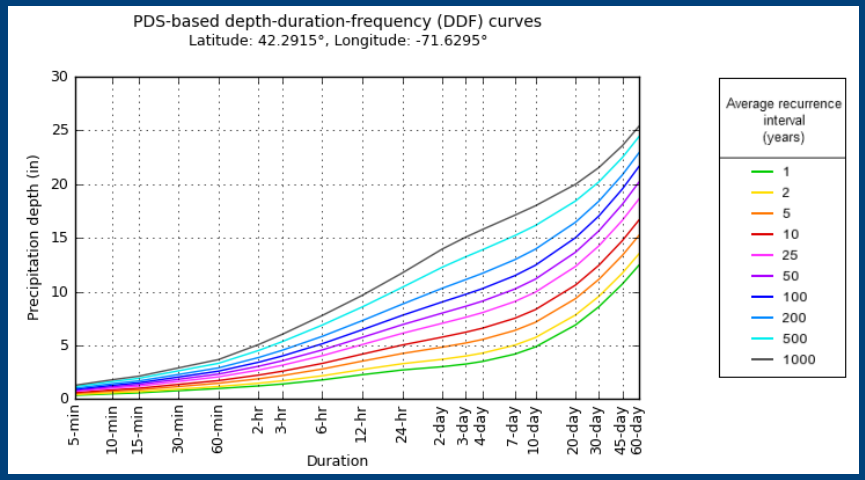
- Droughts

- Flood

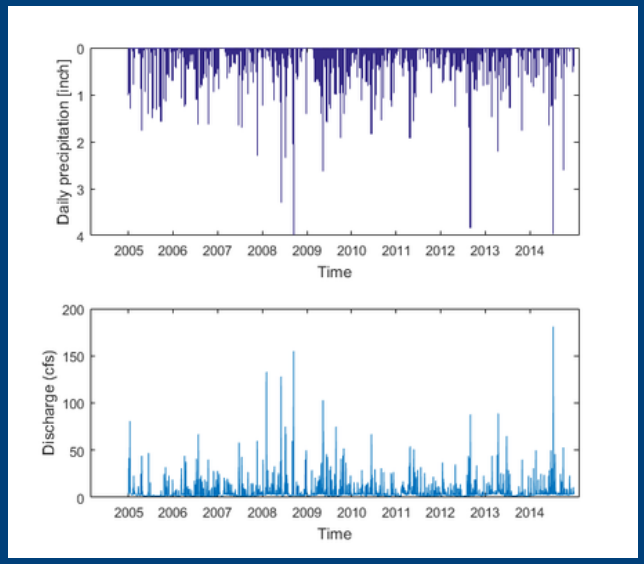
Carrabassett, ME Rt 27

What Kinds of Data do We Use?

- Event-Based Design of Hydraulic Structures
  - Depth-duration-frequency
  - Intensity-duration-frequency

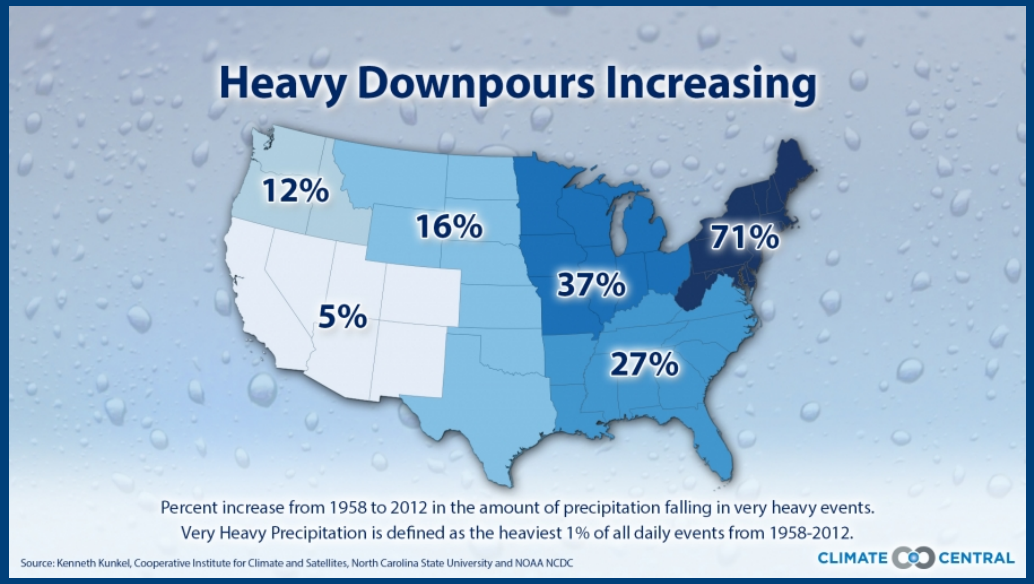


- Continuous Time Series
  - Analysis and design of *systems*
    - **Water supply**
    - **Stormwater**
    - **Sewer**
  - Extremes take care of themselves



Extreme Precipitation

- A HUGE Subject
- Bigger than a 6-hr workshop
- Time now to limit my comments
  - Hydrologic design in transportation
    - **Hydraulic Structures**
    - **Civil / site design**
    - **Stormwater**
  - Northeast US
  - Rural state



Hydrologic Design in Transportation

- All about “Sizing the Structure”
  - Bridges, culverts, pipes
- Design for *flow* of specified frequency
  - E.g. Q50 - “50-year flow”, “50-year event”
- Calculate flow by regression equations
  - Precip may not even be needed!
- Calculate flow *from precipitation* by a rainfall - runoff (R/RO) model (urban & smaller watersheds)
  - Assume T-yr rainfall event produces T-yr flow
- Typically assume steady flow hydraulics **
  - Don’t need hyetograph or time series

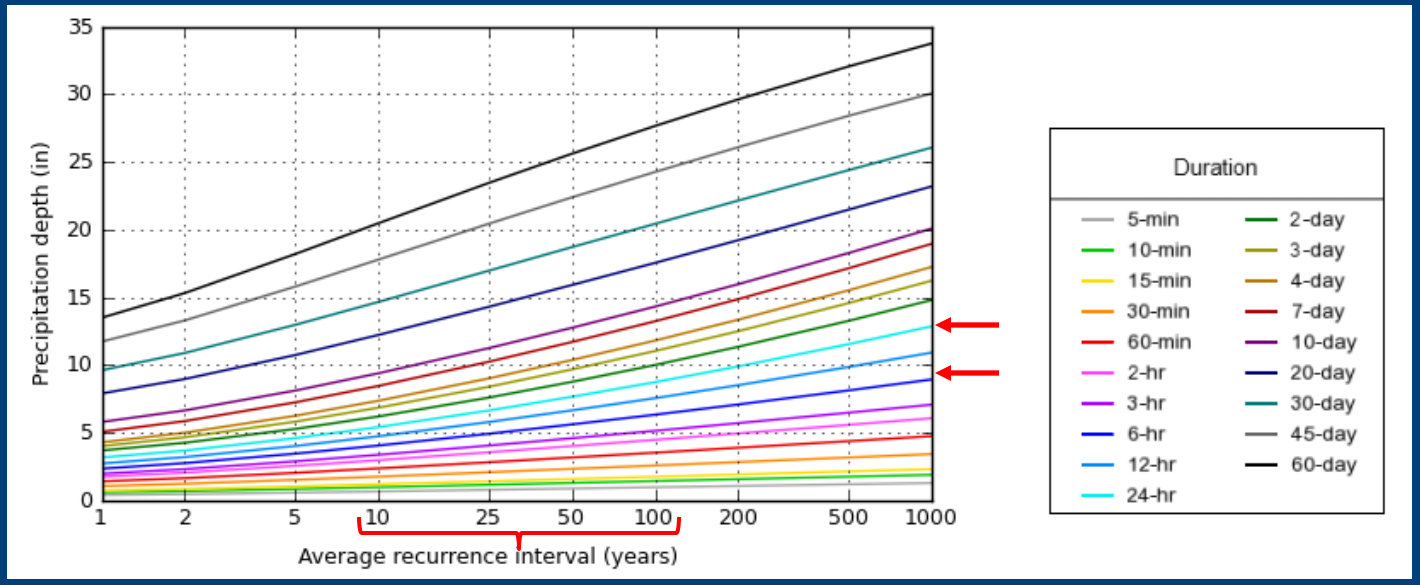
R/RO Calculators Used in Design

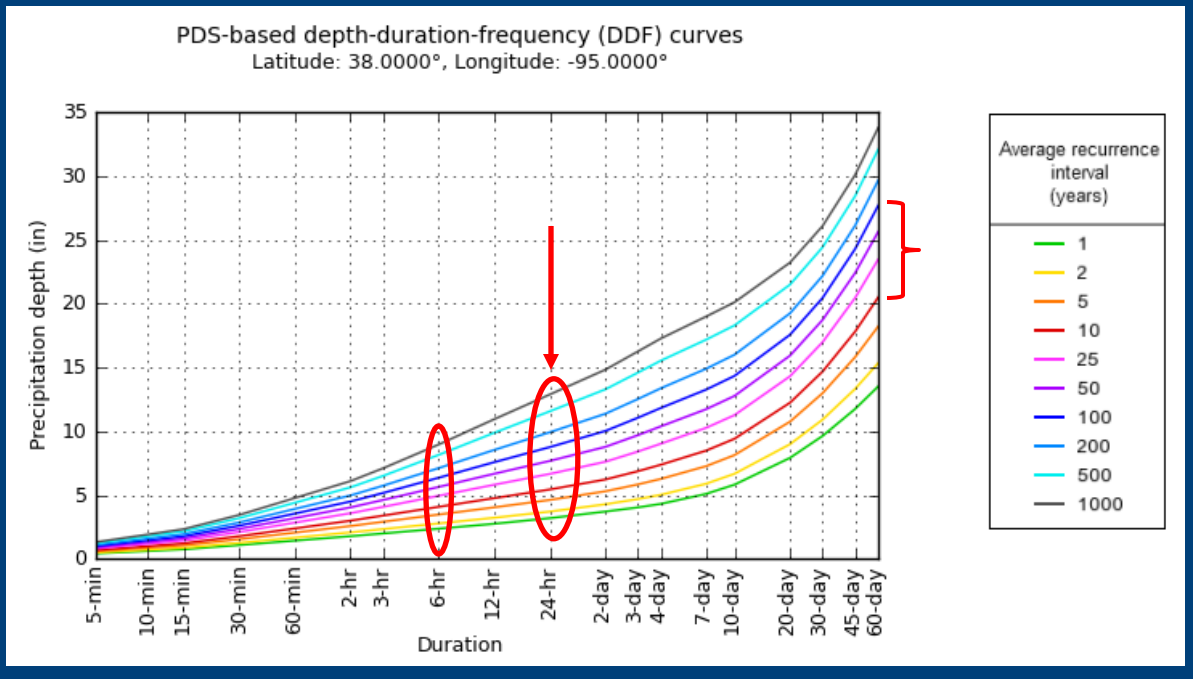
- Rational Method *(intensities)*
  - Q = CiA
- TR-20 (NRCS) *(24-hr depth)*
  - Hydrograph method
  - And derivatives

    (ex. HydroCAD, TR-55, parts of HEC-HMS))
- Almost never “calibrated” to real data
- Large, *Unknown* Uncertainties
  - In the precip inputs, the model & model parameters

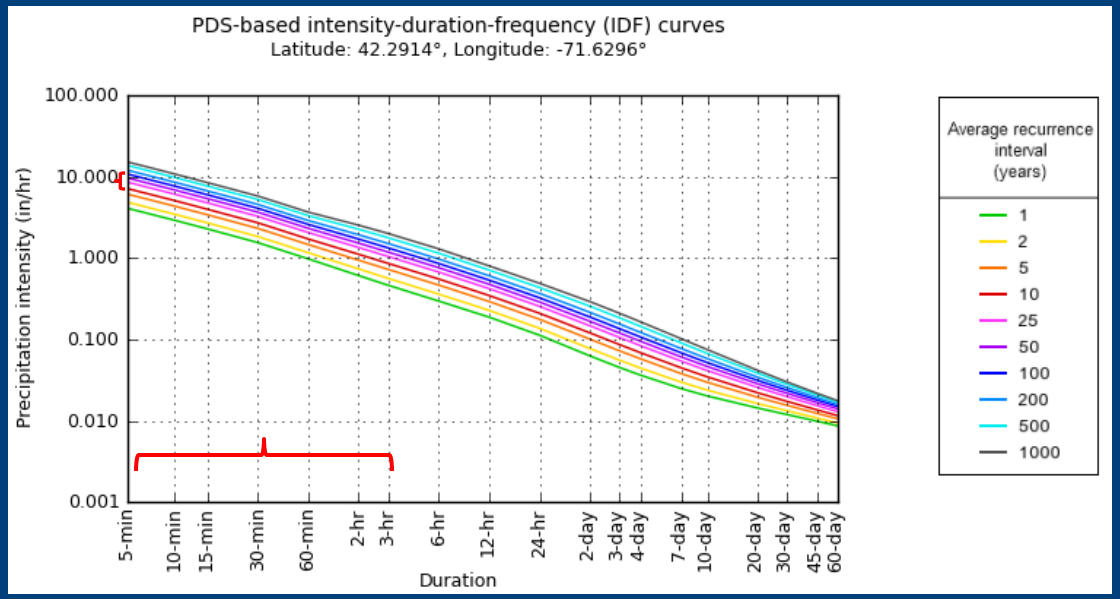
NOAA Atlas 14

- Standard Source for precip inputs to event-based hydrologic models
  - Also *precip.net* for the Northeast
- DOT's have a particular interest in Atlas 14
  - Principal funding partners with NOAA
  - Replaces workhorse 50-yr old TP-40
- Depth-Duration-Frequency (DDF) Curves
  - For TR-20 hydrology
- Intensity-Duration-Frequency (IDF) Curves
  - For Rational Method

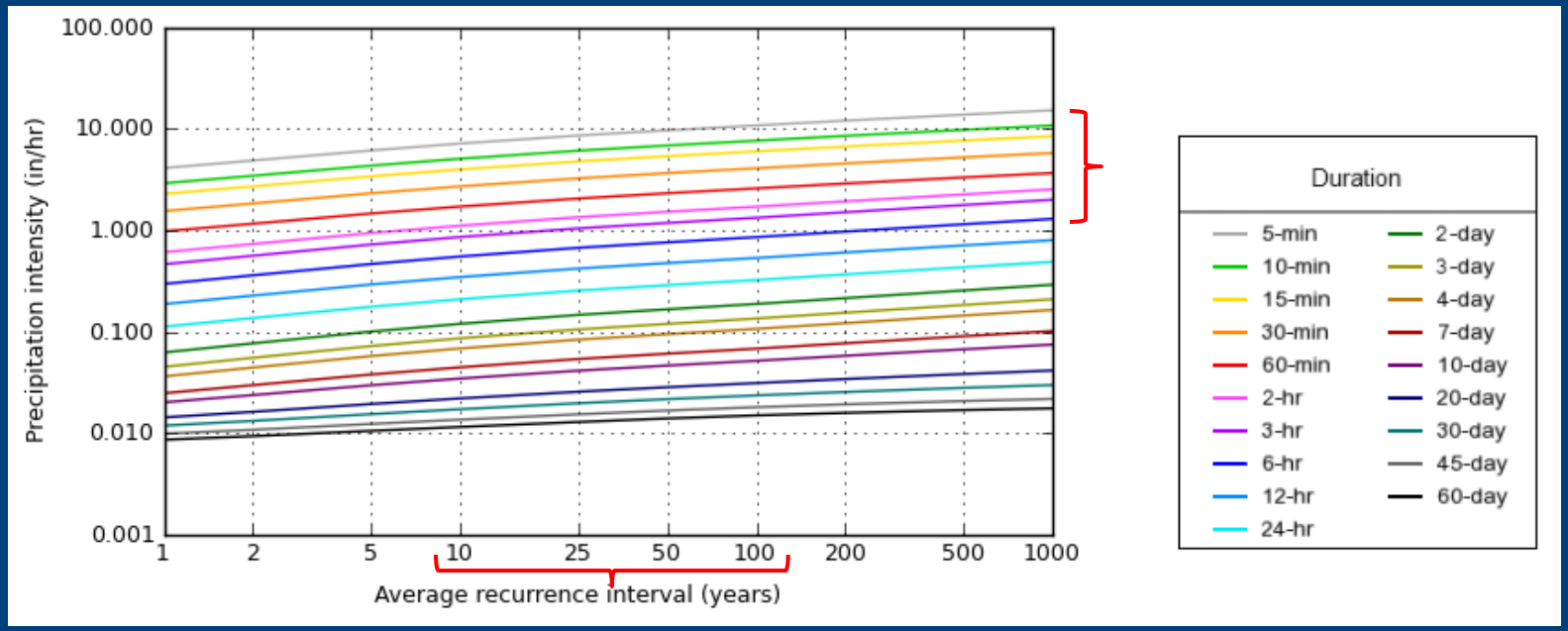




Depth – Duration - Frequency



Intensity – Duration - Frequency



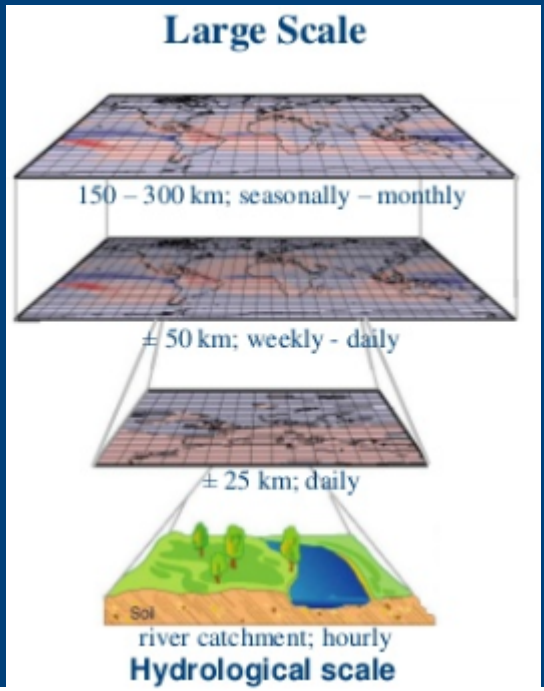
Now and Then – and Tomorrow?

- Atlas 14
  - Looking back
  - historic data (thru 2010 or so)
- Next update probably 20+ years away
- What about tomorrow?
- How to incorporate climate projections in design?

Should we even try?

Climate Projections?

- Daily time step
  - Design needs (R/RO): sub-daily, even sub-hourly
- Grid Size 10 – 100 km (100 km^2 – 10,000 km^2)
  - Design watersheds (R/RO) 1 ac – 640 ac (0.004 – 2.6 km^2)
- Need to *DOWNSCALE*
  - Space
  - Time (disaggregate)
- Climate models not intended for these small space & time scales



What is Needed for Design?

- Projected IDF, DDF curves & tables
  - Use same R/RO design tools
- Focus of ongoing NCHRP research
- Small urban and flashy watersheds likely most at need
  - Strongest relationship bet Rainfall & Runoff
- Larger watersheds?
  - R/RO relationship much more complicated

Wait a Minute!

Step back – take a deep breath

- Don't just automatically go to design with projections
- Time to look at uncertainty in current IDF / DDF
- Doesn't come naturally
  - *"Give me a number"*
- Need a design protocol to look at projections *and* existing uncertainty

Duration	Average recurrence interval (years)			
	10	25	50	100
5-min	**0.597** (0.451-0.785)	**0.716** (0.525-0.981)	**0.806** (0.581-1.13)	**0.900** (0.631-1.30)
10-min	**0.846** (0.638-1.11)	**1.01** (0.744-1.39)	**1.14** (0.822-1.60)	**1.27** (0.894-1.85)
15-min	**0.995** (0.751-1.31)	**1.19** (0.876-1.64)	**1.34** (0.968-1.88)	**1.50** (1.05-2.17)
30-min	**1.36** (1.02-1.78)	**1.63** (1.19-2.23)	**1.83** (1.32-2.56)	**2.05** (1.44-2.96)
60-min	**1.72** (1.29-2.25)	**2.06** (1.51-2.82)	**2.32** (1.67-3.25)	**2.59** (1.82-3.76)
2-hr	**2.22** (1.69-2.91)	**2.70** (1.99-3.69)	**3.05** (2.21-4.26)	**3.42** (2.43-4.97)
3-hr	**2.58** (1.96-3.37)	**3.14** (2.33-4.29)	**3.55** (2.59-4.96)	**4.00** (2.85-5.81)
6-hr	**3.31** (2.53-4.30)	**4.03** (3.00-5.48)	**4.56** (3.34-6.34)	**5.14** (3.68-7.43)
12-hr	**4.17** (3.21-5.39)	**5.07** (3.79-6.84)	**5.73** (4.21-7.91)	**6.44** (4.63-9.25)
24-hr	**5.02** (3.88-6.46)	**6.11** (4.60-8.22)	**6.92** (5.11-9.50)	**7.79** (5.62-11.1)

- We have time to reflect, ponder & act responsibly
- We are *not* facing a crisis when it comes to sizing structures for changing precipitation